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THE BEGINNINGS OF SOCIAL BEHAVIOR IN UNICELLULAR ORGANISMS[1]

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BY social behavior we mean the behavior and reactions of individuals with relation to other individuals as such; reactions to individuals as individuals, either singly or in combination, not merely reactions to physical forces or to masses present in the environment.

How far down in the biological scale does such social behavior extend? Are social urges and instincts and reactions part of the life of the very cells of which organisms are made? Or are they manifestations only of relations that have first come into existence in the great complexes of cells that constitute higher organisms?

I have of late been forced in the course of investigations to become intimately familiar with the daily and most private life of certain organisms, each of which is a single microscopic cell. The phenomena that thus come under observation throw light on the most primitive manifestations of social behavior. I shall try to present the main features of these phenomena, with certain of the reflections and conclusions to which they give rise. They raise the question: What is the nature of the earliest manifestations of social behavior; and perhaps they help us to answer it. They bear also upon the problem of the unity of the manifestations of life in higher and lower organisms. And they lead to a reconsideration of certain other questions that are related to the problems of social behavior: particularly to a question that has been discussed as the problem of self-consciousness in animals.

[1] Leidy Lecture, delivered before the section on Natural Sciences of the University of Pennsylvania Bicentennial Conference, Philadelphia, September 18, 1940.

I must, then, first ask you to make the acquaintance of the single-cell creatures about which our discussion will center and to follow some of their manners and customs. These creatures are minute green particles, so small that the single individual is hardly visible to the naked eye: their acquaintance must be made under the microscope. They are animals, although they are green; the green color is due to extremely minute plant cells that are growing within their bodies. They are typical ciliate infusoria. This species has received the name *Paramecium bursaria*. They live in fresh water, among lily pads and other plants. They may be kept alive under the microscope, in a few drops of water, or in a single drop. Their generations may be followed for months or years in the laboratory.

Each of these animals is constructed as a single cell, having one large active nucleus and a very minute reserve nucleus. The individual, though a single cell, is complex in structure, having parts which serve as mouth, as organs of locomotion, as sensory and conducting structures, as secretory and digestive portions.

The manifestations of social life that appear most deep-seated—remaining among the most conspicuous even at the stage which we humans have reached—are those connected with mating and the family. In the infusorian, too, these are conspicuous; they will form the basis of our discussion. We shall try to gain an insight into what might be called the courtship, mating, family life and social system of the infusorian.

In the infusorian, as in man, it is not the custom for close relatives to mate. Families are very large. The single individual, as you know, divides into two; these two soon divide again into four, and this continues, so that in a few days the single individual has produced a large family. Such a family is a set of identical twins, containing not two, not five, but thousands, of individuals. Such a family is called a clone.

The members of such a family do not mate together. But if members of an unrelated family are introduced among them, mating occurs between the unrelated individuals. And the behavior of the organisms leading up to the matings is of an extraordinary character.

On the introduction of unrelated individuals, or on mixing two unrelated families in the same drop of water, there is a sudden and strong reaction. The individuals of the different families cling together. Several individuals of one family may cling to one individual of the second family. These are joined by other individuals of both families. In this way tight groups or clots are quickly formed, many individuals of the two families adhering together as if their bodies were covered with glue. They thus form masses of dozens or hundreds of adherng individuals. (See the photographs of this behavior in the papers of Jennings,[2] 1939 and 1939*a*; these photographs were here shown on the screen.)

In these clotted masses the individuals adhere firmly together, as if covered by some adhesive material. The clinging together is not an active reaction, nor is it brought about by organs of attachment. It appears to be a physical adhesion; any part of the body of one individual thus adheres to any part of the individual of the other family. Often an individual visibly struggles as if trying to escape from the attachment to another individual, but in vain.

The great clotted masses remain thus with the component individuals stuck irregularly together for some hours. Then they begin to break up into smaller clots and often into chains of individuals attached end to end. This breaking up continues perhaps for two or three hours, the clots becoming smaller, until there remain only groups of two.

That is, in the course of this long and irregular adhesion the individuals constituting the two families have paired off, two by two, so that now almost all the individuals are in pairs (see the fourth photograph of those published by Jennings, 1939 and 1939*a*; this was here shown on the screen). In every case the two individuals of any pair are members of the two different families. This is readily demonstrated when the individuals of the two families differ in color or in other ways, as is often the case.

The two mates remain intimately united for 24 to 36 hours. While united they exchange halves of their nuclei, halves of their chromosomes (see the figures published by Chen,[3] 1940: these were shown at this point on the screen). They then separate. Each individual is now a new combination of nucleus and cytoplasm, since each has lost half of its chromosomes and has received half of its mate's chromosomes.

These are the fundamental phenomena, sketched in their simplicity. But, as you will see, the phenomena are subject to many variations and conditions. When the manners and customs connected with mating are observed, one finds them surprisingly complex. There is, as it were, a complicated code of taboos, inhibitions and permissible practices connected with the mating behavior: a complex social system.

It was mentioned at the beginning that members of the same family or clone do not thus cling together and mate, while members of different families may do so. But it is by no means true that members of *any* two different families will mate. Some families quite refuse to unite; if mixed together they continue to swim about freely and indifferently. Members of other families unite readily in the way described.

[2] H. S. Jennings, 1939, *Genetics*, 24: 202–233; 1939*a*, Introduction (pp. 385–389); *Paramecium bursaria* (pp. 414–431) *Am. Nat.*, 73: 385–456.

[3] T. T. Chen, 1940, *Jour. Hered.*, 31: 185–196, 1940.

This selectiveness is not a temporary matter; families 1 and 2 never mate, no matter how often their members are brought together; and the same is true of families 1 and 3; they never mate. But members of families 1 and 4 clump together and mate whenever they are mixed.

In higher organisms, of course, there are two differing sets of individuals, such that members of one of the sets never unite together, but members of one set may mate with members of the other set. We call these two sets the two sexes.

Is this the situation also in the infusorian? Does family 1 belong to one sex, family 4 to the other sex—so that they will mate together? Do all families that will not mate together belong to the same sex?

There are no visible differences, no structural differences, between the two individuals or families that mate together. So far as one can see the two are exactly alike. But of course there might be chemical differences distinguishing the two sexes.

Whether there are thus two sexes, all families belonging to one or the other, is readily determined by successively mixing different families. Before showing what happens in such successive mixtures the result of the observations may be stated. Prolonged study shows that there are not two sexes. On the contrary, there are four different sets, or in one variety eight different sets, which mate together, or refuse to mate together according to sharply defined rules.

These things are discovered in the following way: Two families, which we may call A and B, mate when mixed together, so that if there are two sexes, A represents one sex, B the other. With family A we mix a third family. These two refuse to mate. This third family must therefore be of the same sex as A. We will call it A1. Next we mix another family, which we may call C, with family A. We find that A and C mate together, so that C would have to be considered, like family B, a member of the opposite sex from A: it should then be of the same sex as B. We try mixing families B and C together. But we find that they mate together. So it is clear that B and C do not belong to the same sex. C does not belong to the same sex as either A or B. It belongs to a third type. A and B mate together and C will mate with either of the two.

We are evidently not dealing simply with two sexes. We have thus far found three types, A, B and C. To each of these belong many families, so that we may distinguish A1, A2, A3, B1, B2, B3, C1, C2, C3, and so on. There are many families that act like A; they will not mate with any other family belonging to the A type, but will mate with any family belonging to the B type or to the C type.

And as we continue making mixtures, we presently come upon a fourth set of families, which we may call D. Any family that belongs to the D set will mate with A or with B or with C, but no two families of the D set will mate together. These creatures are divided into castes, which mate or refuse to mate according to rigid rules. Members of any one set or caste will not mate with other members of that set, but will mate with members of any other set. In the variety with which we have thus far dealt there are just four of these castes.

If we call our four castes by the letters A–B–C–D, the mating relations between them are represented by Table 1 (on the screen).

TABLE 1

	A	B	C	D
A	–	+	+	+
B	+	–	+	+
C	+	+	–	+
D	+	+	+	–

A plus sign indicates that the two sets readily mate together; a minus sign that they do not.

Many different and unrelated families belong to type A, many to type B, many each to types C and D.

How do members of the different castes recognize each other? There must be some chemical or delicate physical differences among the four different types. When two individuals of different type come in contact they stick together just as if their surfaces were covered with a strong adhesive. But when members of the same type come in contact they do not stick together. The adhesion is a reciprocal relation between diverse types, not a general tendency to adhere to objects.

The mating relations between the individuals thus turn out to be somewhat complex, in a systematic way. But the half has not yet been told. As we continue to extend our acquaintance among different families of the green Paramecium, we come upon another set of families that will have nothing to do with the families that constitute the four castes that we have called A, B, C and D. Mix animals of the new set of families with any of those of the four types just mentioned. The individuals pass each other by undisturbed, unmoved—even though they may come into actual contact. There is no adhering together; no forming of clots or pairs.

But members of different families belonging to this second group quickly respond to each other. They cling together, form clots and pair off just as occurs in families of the first group. The families in this second group, like those in the first group, belong to different castes or types. Prolonged study shows that in this second group there are eight different types, in place of the four of the first group. Members of

families that belong to the same one of these eight types will not mate together. But they mate at once with members of any of the other seven types of this group, though they will not mate with any of the types of Group I.

If we call the eight types of this second group by the eight letters of the alphabet from E to M, then the mating relations of the eight types to each other are shown in Table 2 (on the screen).

TABLE 2

	E	F	G	H	J	K	L	M
E	−	+	+	+	+	+	+	+
F	+	−	+	+	+	+	+	+
G	+	+	−	+	+	+	+	+
H	+	+	+	−	+	+	+	+
J	+	+	+	+	−	+	+	+
K	+	+	+	+	+	−	+	+
L	+	+	+	+	+	+	−	+
M	+	+	+	+	+	+	+	−

In Table 2 a plus sign indicates that two families of the types indicated readily mate together, while a minus sign signifies that they never mate together.

It is remarkable that in all this complex and rather violent mating behavior, the animals observe rigidly certain hours. The adhesion and mating is limited to certain times of the day. It does not occur in the early morning, nor in the evening after five o'clock, nor in the night. It begins at about 8 or 9 in the morning, but the tendency to unite is then very weak; the animals cling together only faintly, in small groups. As the day wears on the tendency to cling together becomes stronger; large groups are formed, in the way that was shown in the photographs. At about four in the afternoon the tendency to cling together may be seen to weaken. The large groups earlier formed break up, and by 5 or 6 o'clock the individuals have completely separated and are swimming about singly again —except the ones that have already become firmly united in pairs. If in the morning or evening we mix together families belonging to different types, they swim about undisturbed, not adhering together nor forming pairs; though the same families if mixed in the middle of the day at once adhere in clots and masses and form pairs.

The conditions thus far described are not the end of the social complications in our infusorian, *Paramecium bursaria*. The social system is indeed enormously complex. There is still another group of families that will not react or pair with any of the families that belong to Group I, nor with any of those that belong to Group II. But the families of this third group mate together in ways and according to rules that are like those already described for Groups I and II. There is one curious difference, however. In this Group III mating is not limited to certain hours, but will occur at any time of the day or night. In this third group there are, it turns out, just four castes or mating types, as there are in Group I. If we call the four mating types of this group by the letters N–O–P–Q, their mating relations are those shown in Table 3 (on the screen).

TABLE 3

	N	O	P	Q
N	−	+	+	+
O	+	−	+	+
P	+	+	−	+
Q	+	+	+	−

Families belonging to any one type will not mate together. But families of any one of the types will mate with families of any of the other three types.

Thus our microscopic green cells are organized socially into sixteen different mating types, which are divided into three large groups, in the way shown in Table 4 (on the screen).

TABLE 4

I	II	III
A B C D	E F G H J K L M	N O P Q

Members of any one group will not react or mate with members of either of the other two groups. Within any group there are several mating types—four in groups I and III, eight in group II. These mating types within the groups mate with each other in accordance with the rules already set forth. The entire complex system of mating is indicated in Table 5 (on the screen).

TABLE 5

		I				II								III			
		A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
I	A	−	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−
	B	+	−	+	+	−	−	−	−	−	−	−	−	−	−	−	−
	C	+	+	−	+	−	−	−	−	−	−	−	−	−	−	−	−
	D	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−
II	E	−	−	−	−	−	+	+	+	+	+	+	+	−	−	−	−
	F	−	−	−	−	+	−	+	+	+	+	+	+	−	−	−	−
	G	−	−	−	−	+	+	−	+	+	+	+	+	−	−	−	−
	H	−	−	−	−	+	+	+	−	+	+	+	+	−	−	−	−
	J	−	−	−	−	+	+	+	+	−	+	+	+	−	−	−	−
	K	−	−	−	−	+	+	+	+	+	−	+	+	−	−	−	−
	L	−	−	−	−	+	+	+	+	+	+	−	+	−	−	−	−
	M	−	−	−	−	+	+	+	+	+	+	+	−	−	−	−	−
III	N	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+
	O	−	−	−	−	−	−	−	−	−	−	−	−	+	−	+	+
	P	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−	+
	Q	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	−

But the account of social behavior in these single cells is not yet complete. Description has been given

of the behavior which culminates at once in the mating of the individuals: behavior that is regulated in accordance with manifold and systematic preferences and inhibitions. In its operation this behavior appears a bit brutal. The individual (I had almost said the victim) is as it were seized and dragged struggling to the pairing. One is reminded a bit of the shotgun marriages of melodrama. This violent character of the behavior is striking as one observes particular individuals. Two individuals of different mating type (but belonging to the same group) are swimming about in the graceful way characteristic of these minute animals. Accidentally they come in contact. Thereupon they stick firmly together by any parts of the body that happen to touch. Both are brought to a halt with a jerk. Each tries to continue in the direction it was going. The stronger one drags the other away against his efforts—drags him backward or sideways. Such an adhesion may finally after a struggle result in a complete mating. Or other individuals get stuck to one or the other of the two, so that several or many individuals become stuck together in irregular ways; they flounder about helplessly. Sketches of such adhering individuals, irregularly united in groups of two or three or four, are given by Jennings 1939 (footnote 2), Fig. 3 (reproduced on the screen). The individuals seemingly fall helpless victims to the mating reactions.

But as in higher organisms, there is other behavior that tends in the same direction, yet is not violent and brutal; behavior that appears merely a preparation for the definitive mating reactions: behavior that may or may not lead to the selection of a mate. This behavior is of a type that tempts one to characterize it as the objective aspect of courting, or perhaps in some cases flirting.

This behavior shows itself, not in great mass reactions such as were earlier shown in photographs, but in the activities of individuals—or rather of pairs of individuals. Two individuals touch each other gently. They do not stick together, but swim off in coordinated motion side by side, continuing in contact. They proceed in a graceful path—a spiral—through the water. They may keep this up for but a few seconds, then separate, or it may continue for a much longer time, leading finally to a mating of the two. Most often, however, this caressing behavior lasts but a few moments, then the two individuals separate—possibly coming together again in a similar way a few seconds later. Sketches of characteristic postures and motions in such behavior are given by Jennings, 1939 (footnote 2), Fig. 2 (reproduced on the screen).

There is great variety in these reactions, the one common feature being that the individuals swim together in a coordinated way, in such a manner as to keep their bodies in contact. The bodies may shift, changing the regions of contact; then the two continue in coordinated motion as before. The two after swimming a considerable distance together may separate for a short distance, then come together again. As the animals swim in a graceful spiral, they make a pretty sight, reminding one of couples in a dance.

Such behavior often occurs in two individuals that belong to different mating types. In these cases the gentle caressing behavior is often after a time replaced by the strong physical adhesion before described, and the two individuals finally unite in conjugation.

But such behavior is also seen in pairs of individuals that belong to the same mating type, so that they never finally mate. Such pairs swim about in the varied coordinated way that I have described, but finally separate. It appears that the function of this type of behavior is that of a trial: it gives opportunity for the violent adhesive type to supervene if the two individuals are appropriate mates.

It is a curious fact that although the spectacular clumping in great masses which you have seen in photographs was only recently discovered in these animals, this gentle behavior—courtship or flirting as it might be called—was seen long ago in some of the infusoria. The older microscopists of fifty years ago were a good deal excited about it and its possible psychological implications. One may read a summary of the older observations in the great papers of Maupas[4] published in 1889. Some of the authors described such behavior and its possible, psychological bearing with enthusiasm and exuberance. But zoologists have of late been disposed to frown upon it, to hush it up, pass over it unmentioned. For it is not the sort of behavior that lends itself most readily to formulation in the simple terms that are dear to the hearts of mechanistic biologists—particularly in relation to single cells. Yet this is behavior that does occur in unicellular animals, that is widespread among them, and in relation to the unity of life phenomena among organisms appears of great significance. Certainly any adequate account of the biology of unicellular organisms must deal with these phenomena, as it must also with the entire system of social relations above described.

To complete the sketch of social organization in the infusoria, one other matter is required. Since this organization is based on mating relations, the conditions of youthfulness, adolescence and adulthood play a role. Two mates that unite become the parents of a new generation. After mating is completed, with its formation of new nuclear combinations, the two parents separate, and each multiplies by fission; in this way the two produce a biparental family.

When these descendants of the two parents are

[4] E. Maupas, *Arch. Zool. Exp. et Gén.*, (2) 7: 149–517.

tested, they are found to be immature; they do not mate. They are youthful. They grow and multiply; hundreds of successive cell generations are produced, with millions of individuals. All these individuals are in appearance like the two individuals that have mated to produce them. But all are immature; they have nothing to do with mating. If during this period different families are mixed, there is no adhesion, no clotting together, no pairing.

Months later, among the many individuals of these young families signs of approaching maturity show themselves. In mixtures of different families, a few individuals show a weak tendency to adhere when they touch. In time two or three or half a dozen pairs are formed. This period of adolescence lasts for weeks or months; it lasts for many generations. The tendency to mate becomes slowly stronger, till in time the new individuals show the strong spectacular mating behavior that was first described. The new families are now mature.

When this period is reached it is possible to discover the mating type to which these new families belong. And this enables us to discover the effects of heredity in determining the mating type to which any individual belongs. The two parents of course always belong to different mating types, just as two human parents belong to different sexes. Let us suppose that one was of the type A, the other of type D (as in the case shown on the screen). If these two parents had not mated, but had continued to reproduce without mating, all descendants of A would continue to be of type A, all descendants of D would be of type D. But mating has changed this. After mating the two parents produce descendants that are alike, that are all of the same type. From one pair of parents that are A and D are produced descendants that are all of the A type. From another pair of parents A and D are produced descendants that are all of the D type. In these cases the descendants are all like one or the other of the two parents. Most of the pairs produce families of these types. But a few families whose parents are A and D produce descendants that are all of one of the other two types. Some produce descendants that are all of type B, others descendants that are all of type C (as shown on the screen).

If the parents belong to other types, as A and B or A and C, or B and C or C and D, inheritance occurs according to similar rules. Most of the biparental families produced are like one or the other of the two parents, while a few of them belong to the other mating types, to which the parents do not belong. But in all cases the two families descended from two individuals that have conjugated together belong to the same mating type; so that they do not conjugate together. The two constitute in effect one large family, all of the same mating type.

So at any given time a population of the infusorian, like a population of higher organisms, contains a lot of young, immature individuals, not concerned with mating, a lot of adolescents showing as it were an awakening interest in mating, and a great number of mature individuals, which mate in accordance with the complex social system that has been above described.

The question naturally arises: Does it also contain aged individuals that no longer mate and produce descendants—as does a population of higher animals?

This question has not been fully investigated in Protozoa in which different mating types are known. But the population usually does contain some individuals that are less vigorous than others, as if they had grown old. But these continue to reproduce by division as do both the mature and the immature individuals. Seemingly also they continue to mate. But according to the earlier accounts of Maupas (1889) and of Calkins[5] (1919), in some species at least these less vigorous individuals when they mate do not produce offspring. They do not continue to multiply after conjugation, but soon die. It appears possible that these less vigorous individuals are merely those that have lived under poor conditions and grown sickly. All this is a question that is much disputed among observers of these animals. There is beyond doubt some indication that aged, decrepit individuals are finally produced. By aid of the discovery of the diverse mating types, it is to be hoped that this question may soon be fully settled.

In the population as we find it in nature therefore there occur young immature individuals, adolescents in various grades of development, possibly aged, senile individuals, and mature individuals. Among these mature individuals may be representatives of any or all of the 16 diverse mating types and the three different groups that have before been described.

How far is the situation just described in *Paramecium bursaria* typical for unicellular organisms? Investigation of such matters in the different Protozoa has hardly more than begun. Yet it has gone far enough to show that some such social organization as has just been described is of widespread occurrence among certain classes of Protozoa, particularly in the ciliate infusoria. But the details of organization differ greatly in different species. In *Paramecium aurelia* the extensive researches of Sonneborn[6] (1937–1939) show that there are, as in *Paramecium bursaria,* three groups such that members of different groups will not conjugate together. But any single group is composed

[5] G. N. Calkins, 1919, *Jour. Exp. Zool.,* 29: 121–156.

[6] T. M. Sonneborn, 1937, *Proc. Nat. Acad. Sci.,* 23: 378–385; 1939, *Am. Nat.,* 73: 390–413.

of but two mating types—a situation like that in man and higher animals—in place of the four or eight types found in *Paramecium bursaria.* In *Paramecium caudatum,* Gilman[7] (1939) finds a situation in many respects like that in *Paramecium aurelia.* In the infusorian Euplotes there occur, according to Kimball[8] (1939), many different groups and many mating types in a group.

Turn now to certain general considerations; to interpretations, reflections and conclusions. As to conclusions, the facts speak for themselves so loudly that it is hardly necessary to state them in a general form. Social behavior *is* found in organisms that are single cells; it is even found in what must be called in certain respects a highly complex system.

As to interpretations, you will perhaps agree that in describing these social relations one is tempted to fall into the use of terms that are based on our own human experience, of terms that have a subjective background, terms that relate to conscious experiences. The whole picture tends to emphasize the unity of the biological world in such social relations as those of which I have spoken.

Of course there is no doubt at all that all the manifold social discriminations, attractions and repulsions have in the infusoria chemical or physical correlates; as they have indeed in man also. For many purposes it will be most useful to describe the behavior in terms of these physico-chemical relationships, when they become known; and this is what is usually striven for in scientific accounts. But for other purposes, such as for examining into the question of unity versus heterogeneity in biological phenomena, comparison with conditions in other organisms is required. And when one makes such comparisons, it becomes evident that some of the behavior of these simpler organisms much resembles that which in ourselves has subjective accompaniments, has even conscious awareness of relations. Whether there are faint glimmerings of consciousness in the infusorian we can of course never know.

But one thing we can know. The infusorian has no awareness of the complex social system into which its behavior fits, for the good reason that there is no way in which it could acquire the data requisite for being aware of it—even if it has or had the capability of conscious awareness. For to become acquainted with the system, one must subject himself to the experience of all its components and relations, and this the infusorian has no opportunity to do; it can not know the social system because it has never become acquainted with it.

This situation illustrates an important biological principle: a principle that is indicated and perhaps we may say demonstrated and emphasized by many relations in the biology of behavior. This principle is as follows: In evolution, process and action are primary, consciousness, particularly conscious awareness, secondary. Conscious awareness, as of purpose, function or relations arises (if at all) *after* action: after the course of action has become established. The organism first acts, only later—in later generations—does it discover why it acts as it does, what function is performed by its action. Many things that are consciously done by higher organisms are likewise done by lower organisms, but certainly without that awareness of relations which appears to guide them in the higher animals. The performance of an action, even in accordance with a complex system of relations, comes in evolution before there is awareness of the action—or certainly of its relations. The action is not derived from conscious awareness or purpose, but the reverse is true. The action first comes to be performed, later in evolution the organism comes to be aware of it and of its functional relations. So our Paramecium operates on an elaborate system of social relations, of which it can not possibly be aware. Mankind operates on a social system not too diverse from that of Paramecium, but he is aware of it, and sometimes has consciously planned certain aspects of it.

Social behavior—meaning distinctive and specialized reactions to individuals of one's own kind, such as we have seen in the infusorian—implies and is correlated with another aspect of behavior—an aspect which has always been stated in terms of consciousness. It is known as the problem of "self-consciousness." The individual in his social relations reacts as one individual among others, having attributes similar to those of other individuals. Stated in the subjective terms commonly employed, in self-consciousness the individual recognizes himself as a unit in the social group of individuals of his own kind. It has long been the custom to assert that while animals doubtless are conscious, only man has self-consciousness. The possession of self-consciousness has been asserted as a great distinctive feature of man. This is a traditional and hallowed doctrine, one that keeps for man his unique place in nature.

But certainly the objective correlate of self-consciousness is seen in organisms that react socially; organisms that find their place in a social system such as we observed in the infusorian. Such organisms react as members of a particular group; they react to individuals of that group (and of that only) as to fellow creatures of their own kind. In the mating behavior they declare themselves, as it were, to be individuals of the same kind as their mates. In these lowest organisms this is presumably done without con-

[7] L. C. Gilman, 1939, *Am. Nat.,* 73: 446–450.
[8] R. F. Kimball, 1939, *Am. Nat.,* 73: 451–456.

scious awareness of the relations involved. If so it is again an example of the fact that types of action come first, awareness of the relations involved coming later in evolution.

In animals that are more complex this type of action has developed in such a way as to indicate that there has arisen conscious awareness of the self as an individual among other like individuals. This is shown in many ways beside the mating behavior; one of the most striking of these is the exhibition of jealousy. When a dog is caressed in the presence of another dog the second dog is disturbed; he seeks to substitute himself for the one caressed. It is difficult to see how a creature that is unable to speak could indicate more clearly that he realizes himself to be an individual like the other dog, that he and the other dog are rivals. Such jealousy, with the same implications, is shown by many of the higher animals.

Related to this, and with a similar significance, are the demands of many of the higher organisms that dominance and subordination be observed; that the rights of precedence be not infringed. Any one who in his youth was accustomed to drive home the cows knows with what indignation it was received when one of the subordinates attempted to go first through the gate. It was quickly put in its place by well-directed shoves from the horns of the cow that had in earlier contests made good her claim to precedence.

This matter of dominance, of group precedence, in animals has of late been studied systematically, so that knowledge of it is by no means now in the anecdotal stage. Bird society has recognized orders of dominance, established originally by contests among individuals. This order of dominance is commonly known as the "pecking order." A certain individual established his right to peck, or to threaten to peck, any of the other members of the flock. The others recognize their subordinate relation and receive the pecking without resistance or resentment. Another individual is No. 2 in the pecking order, and so on down the line, there being a complete hierarchy.

Such demands for precedence, such recognition of one's self as a subordinate, or as occupying a clearly defined place in the social hierarchy, seem clearly to involve a consciousness of the self as an individual among others; or at least they involve the objective correlate of self-consciousness. Unless we arbitrarily deny all consciousness to other organisms than man, we can not consistently deny to them self-consciousness: that is, awareness of the self as an individual among like individuals. The attempts to reserve self-consciousness as a distinctive attribute of man therefore appear to be outmoded; they appear out of touch with scientific knowledge.

Among the many features of social behavior in animals that carry similar implications, doubtless the most primitive is the behavior in seeking mates. It is found generally in unicellular organisms. Indeed it is doubtful whether any organisms exist in which it does not occur. The seeking of mates appears to be the fountain head of both social behavior and self-consciousness. It involves the recognition of mates as of one's own kind; and correlatively the recognition of the self as of the same kind as mates. Here social consciousness and self-consciousness have their roots.

OBITUARY

RODNEY HOWARD TRUE

RODNEY HOWARD TRUE during his active and productive life lived through many stages in the development of botanical science here in America. His contributions, of which there are about seventy listed in the Department of Agriculture catalogue, cover many different phases of botanical work. Always interested in men and in human welfare, he was associated in the various papers with many other prominent botanists of his time. His breadth of interest is shown in his activities, the associations he founded and fostered, the various and diverse character of his publications and, above all, by his sincere and wholehearted appreciation of his associates. It would be impossible adequately to express this humanistic side without diverting too far from the scope of a notice such as this. He helped others often at great personal sacrifice and resigned from the Bureau of Plant Industry to meet a budget cut rather than reduce his staff in salary or number. This was done with no position in sight, for he preferred a personal sacrifice to administrative injustice to the members of his staff. Many people looked to him for scientific advice which he was always ready to give, for help with personal matters and for pecuniary help in times of great need. This trait led him to take an active part in the welfare of federal employes, to work for a better organization of scientific and technical men and to serve on the Committee of 100 of the American Association for the Advancement of Science on scientific research. He was a leader in organizing the Agricultural History Society, founded in 1919 and incorporated in 1924, and was the first president of the society. He also served on the executive committee and was a life member of that organization. He was also a member of the general committee to revise the U. S. Pharmacopœia in the ninth edition.

He was a member and held important offices in many organizations such as the American Association of

University Professors, Botanical Society of America, Ecological Society, American Agricultural History Society, Pennsylvania Botanical Society, Pennsylvania Horticultural Society, Pennsylvania Forestry Association, Philadelphia Academy of Science, American Philosophical Society, Society of Naturalists, fellow American Association for the Advancement of Science; also a member of Phi Beta Kappa, Sigma Xi and Delta Upsilon. He was also on the Advisory Council of the Allegheny Forest Experiment Station.

Born in Greenfield, Wisconsin, in 1866, he was graduated from the University of Wisconsin in 1890 with the degree of B.S. He served in the department of botany as fellow and received the M.S. in 1892. Following the lead of so many other American botanists of that period, he went to Leipzig, where after two years' work with Dr. Pfeffer he received the Ph.D. degree in 1895. Having taught in the common schools of Wisconsin and been principal of the Wisconsin Academy at Madison from 1892 to 1893, he was appointed instructor in pharmacognosy in the University of Wisconsin from 1895 to 1896 and as assistant professor from 1896 to 1899. He then lectured in Radcliffe College and Harvard University from 1899 to 1901. At this time (1901) he was appointed plant physiologist in charge of plant physiological investigations in the Bureau of Plant Industry of the United States Department of Agriculture. This division also included drug plant, poisonous plant and fermentation investigations. This position was held until he resigned in 1920. Shortly after he was appointed professor of botany and director of the Botanical Garden at the University of Pennsylvania. This position he held until 1937 when he retired from the professorship but remained director of the Botanical Garden until his death on April 8, 1940.

His botanical publications began with a study of the flora of Madison, Wisconsin, and with studies of the mosses. Undoubtedly he was influenced by Professors Barnes and Kahlenberg in his earlier work. The physiological side was emphasized in such titles as effect of turgor and temperature on growth, electrolytic dissociation, algae and antiseptics, plasmolyzing agents and the poisonous effects of phenol. Drug plants came in at the very first in such titles as betel chewing, drugs of Ceylon and folk materia medica, and in 1904 the drug plant work seems to predominate with papers on cultivation in the United States of such drugs as ginsing, camphor and paprika. Along with these investigations were studies of curing and keeping qualities of lemons. The interest in mosses was still evident, and the swing to plant nutrition evinced very early became dominant about 1914 in such studies as toxicity and malnutrition, harmful effects of distilled water, exchange of ions in nutritive solutions, studies of lime and magnesia, of alkaloids, oxidases and latex and the absorption of calcium salts. Studies of normal and blighted spinach, of the ash of spinach as affected by concentrated solutions, and calcium in the nutrition of plants, of the effect of illuminating gas in soils on plants were gradually giving way to an interest in the history of botany and agriculture. As early as 1916 he published on Thomas Jefferson in relation to botany. Then Lewis and Clark, John Bradbury, Sachs, Michaux and Jefferson claimed his attention. A swing toward horticulture is evinced in later works on pecan, viburnum, Dutch elm and pine diseases and the work of the Morris Arboretum.

In many ways True was a pioneer, pushing into new worlds and reporting back with great enthusiasm, always looking for a new interest but holding to the old with undiminished enthusiasm. This enthusiasm, to a great degree, he could pass to his staff by his ability to lay out and plan experiments backed by an interest in the younger workers which stimulated them by his faith in their ability and evident satisfaction in their accomplishment. This led to a real affection for him by his subordinates. Informal gatherings in the laboratory or greenhouse for discussion of problems brought together men in related fields and did much to maintain a cooperative scientific atmosphere in the Bureau. One of his men, now a prominent botanist, says of him in a personal letter: "I've never known any one who was more generous in his appraisal of his employes or more good-hearted in his relations with them. He was a vigorous champion of research."

With such broad interests, with so much humanitarian interest, his greatest contribution was the opportunity he afforded to others to interest themselves in their own special problems. The list of men who profited by this atmosphere would include many leading American plant physiologists.

Science to True always meant a contribution to human welfare, and the welfare of the scientific worker was always important to him.

H. L. SHANTZ

HOWARD J. BANKER

HOWARD J. BANKER died in his home at Huntington, Long Island, on November 13. He was born in Schaghticoke, New York, on April 19, 1866, the son of Amos B. Banker and Frances Alcena Welling. He is survived by his wife, the former Mary Eugenia Wright, of Clifton Park, New York, and a nephew, Walter B. Banker, of Wilmington, Delaware.

He received his A.B. degree from Syracuse University in 1892 and his Ph.D. from Columbia in 1906. He was pastor of the Union Church in Proctor, Vermont, 1895–98; teacher of mathematics in Dickinson

Seminary, Williamsport, Pennsylvania, 1900–01; teacher of biology, Southwestern State Normal School, California, Pennsylvania, 1901–04; professor of biology, DePauw University, Greencastle, Indiana, 1904–14; investigator in the Eugenics Record Office of the Carnegie Institution of Washington, located at Cold Spring Harbor, New York, 1914–33. He was a member of Phi Beta Kappa and Sigma Xi.

His botanical interests, chiefly in the fungi, found expression in a monograph of the Hydnaceae of North America. He compiled a genealogy of the Bancker or Banker families. His interest thus shown in genealogy brought him to the Eugenics Record Office, where he compiled an extensive history of the Bowditch family of Boston as an example of heredity in an aristogenic family. He invented a method of measuring intelligence on the basis of teachers' marks, and this has been applied to the study of inheritance of mental traits in normal populations. His later contributions were in the field of aristogenic human heredity, and he promoted the introduction of personality traits into family histories in order to render genealogical studies of greater scientific and social value.

ALBERT F. BLAKESLEE

RECENT DEATHS

DR. FRANK M. ANDREWS, professor of botany at Indiana University, with which he had been connected for forty-six years, died on November 26 at the age of seventy years.

MARIUS ROBINSON CAMPBELL, who retired as principal geologist of the U. S. Geological Survey in 1932, died on December 7 at the age of eighty-two years.

DR. JOHN AUGUSTUS HARTWELL, surgeon, of New York City, president of the New York Academy of Medicine from 1930 to 1933 and from 1934 to 1939 director of the academy, died suddenly on November 30. He was seventy-one years old.

DR. PAUL FERDINAND SCHILDER, research professor of psychiatry at the College of Medicine of New York University and clinical director of the psychiatric division of Bellevue Hospital, died on December 8 as the result of an automobile accident. He was fifty-four years old.

DR. JOSEPH BEAL STEERE, from 1879 to 1893 professor of zoology at the University of Michigan, died on December 7 in his ninety-eighth year.

A CORRESPONDENT writes that Dr. James Harvey Ransom, since 1921 professor of chemistry and head of the department at the James Millikin University, died on May 30 at the age of seventy-nine years.

SIR HERBERT WRIGHT, treasurer of the Imperial College of Science and Technology, London, known for his work on tropical agriculture, died on October 28 at the age of sixty-six years.

THE death of Dr. Charles Hesterman Merz, the well-known consulting electrical engineer of Great Britain, and his son and daughter as a result of enemy action is announced in *Nature*. He was sixty-six years old. Dr. Merz was a fellow of the American Institute of Electrical Engineers.

SCIENTIFIC EVENTS

DAMAGE TO SCIENTIFIC INSTITUTIONS IN LONDON

A CORRESPONDENT writes: "A further bombing attack was made upon the British Museum (Natural History) during the night of October 15–16. The building was hit by high explosive and incendiary bombs. The damage was not very extensive and was almost entirely confined to the exhibition galleries, but water seepage was reported to have endangered the insect collections. The zoologists and botanists of every nation, including Germany, would view as a major calamity the destruction of the Natural History Museum and its enormous research collections."

The London *Times* reports that the Royal College of Surgeons, in Lincoln's Inn Fields, was comparatively little damaged when a bomb fell in the garden in the center of the square. Windows and their frames were destroyed, doors and partition walls blown down, and several ceilings damaged. The Hunterian Collection had been removed to a place of safety, but some damage was done to specimen jars, particularly in the army medical war collection.

THE CLASSIFICATION OF TOOL STEELS

THE American Standards Association has announced that it has been requested by the American Society of Tool Engineers to undertake a new project on the classification of tool steels by classes of usage. The purpose of this will be to eliminate the guesswork in selecting the proper steel for various uses, thus prolonging tool life, wearing qualities, etc. This project does not concern tool steels alone but also other materials used for cutting tools, such as cemented carbides and stellite.

According to the American Society of Tool Engineers, there are about 1,000 brands of tool steel on the market, of which many are identical or nearly so. Since there are no standards by which the qualities of these multitudinous brands can be judged and classified, the user is bound gradually to drift into a general use of a certain few varieties of tool steel from

which he has happened to obtain generally satisfactory results in the past. Many times, therefore, he may be using the wrong steel for particular applications.

There have been many attempts to classify tool steels by numbering systems or by composition but so far they have been unsuccessful. At present, some steel companies are using a system which classifies tool steels into seven main types, or families, as follows: plain tool steels, oil- or air-hardened die steels for punch press work, oil-hardened die steels for hot work, tough tool steels, high-speed steels, cemented carbides, miscellaneous tool materials, such as "Graphitic Steels." This system of classifying steels has been copied by both manufacturers and users.

The new project for the standardization of materials for cutting tools proposes to index all tool steels by class designation, by manufacturer, by trade name and by classes of usage. The American Society of Tool Engineers believes that this classification of tool steel by types, or uses, rather than by trade name alone will make the choice of the steel for a particular application a simple matter to the user.

THE NEW HYDRAULIC LABORATORY OF THE NATIONAL RESEARCH COUNCIL OF CANADA

THE National Research Council of Canada has recently provided in Ottawa facilities for research on hydraulic structures. Hon. J. A. MacKinnon, chairman of the Committee of the Privy Council on Scientific and Industrial Research, which deals with matters of policy relating to the National Research Council, states that the laboratory has been set up on the recommendation and under the guidance of a committee composed of technical representatives from four Dominion Government departments.

The new laboratory, which is a part of the Division of Mechanical Engineering, has been planned to supplement the limited facilities which are at present available in Canada for work of this kind. Space and equipment have been provided for model research on many classes of hydraulic structure to a scale which will ensure correct flow conditions and freedom from uncertainty regarding "scale effect." The design of structures such as canal locks, dams, spillways, gates and power plant details can be investigated and work may be undertaken on river hydraulic problems of limited extent. Many pipe-flow problems are also within the scope of the laboratory. A feature of the laboratory is the large flow of water available which will be adequate for the largest models that can be accommodated. The present location of the hydraulic equipment is temporary, and the equipment has been designed for more commodious quarters for which plans have been made.

This hydraulic laboratory provides the engineering profession with a useful tool not hitherto available in Canada for the solution of many problems in hydraulic design. Like all the facilities of the National Research Council, the new laboratory is provided to serve the needs of the country, and its facilities are available not only for investigations of national interest, but also for the solution of those specific problems which arise in private industrial development.

THE PROPOSED NEW CANCER HOSPITAL IN NEW YORK CITY

THE Board of Estimate of New York City referred on December 3 to the City Planning Commission between the city, the trustees of Columbia University and the Presbyterian Hospital an agreement which has been under consideration for the last year for the building of a new cancer hospital.

Under this agreement the trustees of the university and the hospital would convey to the city without charge a two-and-a-half acre site adjacent to the Columbia Medical Center, which is valued at $750,000. It is planned that the hospital be ten stories high, large enough to accommodate 315 beds. The total estimated cost is $2,650,000. The capital budget for 1940 of the Board of Estimate includes $350,000 for design and preliminary work, and an appropriation of $600,000 is contained in the capital budget for 1941. The College of Physicians and Surgeons of the Medical Center will collaborate with the Department of Hospitals in the scientific work and in maintenance of the hospital.

The university will nominate the professional staff of the hospital, except for such appointments as are made under the rules of the Municipal Civil Service Commission.

The city is required to build, equip and maintain the hospital. Unless the building is begun within five years of the date of delivery of the deed, the land reverts to the Presbyterian Hospital.

Dr. Willard Cole Rappleye, commissioner of hospitals, who is on leave of absence as dean of the College of Physicians and Surgeons, stated that the hospital should be completed in 1942. If the Planning Commission and the Board of Estimate approve the agreement and the plans, construction will begin in a few months.

SYMPOSIUM ON MALARIA

A SYMPOSIUM on malaria consisting of six programs will be held in Mitchell Hall, College of Physicians Building, 19 S. 22nd Street, Philadelphia, on Monday, Tuesday and Wednesday, December 30 and 31, 1940, and January 1, 1941. The symposium has been organized by Section N (Medical Sciences) as part of the annual program of the American Association for the

Advancement of Science and is jointly sponsored by the American Society of Tropical Medicine, the National Malaria Committee and the American Society of Parasitologists. It represents an encyclopedic coverage of the subject of human malaria as the disease exists in the United States and the regions surrounding the Caribbean. A total of 42 papers has been prepared by outstanding authorities, and the titles are grouped under the following headings: (1) Introduction and Parasitology, (2) Anopheline Vectors, (3) Epidemiology, (4) The Human Infection, Symptomatology, (5) Pathology, (6) Therapy, (7) Control and Eradication.

The desirability of reviewing the present-day knowledge of this disease in the aforestated manner was emphasized some three years ago when reports of the presence of a severe epidemic of malaria in Brazil were made known. The epidemic had appeared subsequent to the introduction of the mosquito *Anopheles gambiae* from Africa to endemic areas in South America. It was apparent to those familiar with the situation that the same tragedy might take place in the United States since malaria is not only indigenous in 36 of the 48 states but deaths have occurred as a result of the infection in practically every state in the Union. On the basis of the experiences in Brazil the sole requirement for its duplication here was the presence of a good transmitter (anopheline mosquito) which might enter accidentally in the ordinary course of airplane transportation. Accordingly an organization committee was appointed by the Executive Committee of the Association to investigate the problem, and the symposium will mark the culmination of two years of active planning by this group.

Investigators in this country have not been callous to the menace of this malady, which is often believed by the laity to be confined to the tropics. From the day when malaria was first recognized as a serious, disabling and frequently fatal disease in the Western Hemisphere, attempts have been made to combat it, and there is some indication that the most malarious areas in the United States are gradually coming under control. Research workers from the various disciplines have been extremely active in contributing to fundamental discoveries in this field; nevertheless, it is recognized that serious gaps exist in our present knowledge of the disease. Even though the causative agent, a microscopic protozoan, was seen and recognized in human red blood cells over 60 years ago, the germ has not as yet been cultured satisfactorily and at will on artificial media; thus, little is known of its food requirements or by-products of growth. Again, the lack of a suitable laboratory animal susceptible to the human parasite is an additional handicap limiting experimental work to studies in man. The present unsettled conditions in the Far East have jeopardized the shipments of the antimalarial drug, quinine. The limited supply of this substance on hand has stimulated a feverish search for a satisfactory substitute. These are some of the urgent problems which will be covered in Philadelphia. It is hoped that the contributions to the symposium will be suitable for publication in monograph form by the association and thus serve as a guide for immediate as well as for future thought and research on this most important disease.

MALCOLM H. SOULE, *Secretary,*
Section N, A. A. A. S.

THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE 1941 meeting of the Pacific Division of the American Association for the Advancement of Science and its affiliated societies will be held at Pasadena, Calif., from June 16 to 21. The host institutions on this occasion will be the California Institute of Technology, the Henry E. Huntington Library and Art Gallery and the Mt. Wilson Observatory of the Carnegie Institution of Washington.

A preliminary announcement descriptive of the general features of the program will be distributed to members of the Pacific Division early in March.

It is hoped that this meeting will be widely attended not only by members resident on the Pacific Coast, but also by members of the association resident elsewhere in the country.

Members desirous of presenting papers are advised to communicate with the secretary of the society before which the paper will be presented, and to submit titles of communications not later than April 25. Brief abstracts are also requested.

THE COLD SPRING HARBOR BIOLOGICAL LABORATORY

AT a recent meeting of the Board of Directors of the Long Island Biological Association the resignation of Dr. Eric Ponder, for the past five years director of the Biological Laboratory at Cold Spring Harbor, was received and accepted with expression of appreciation of his services.

When the laboratory was suddenly bereft of Dr. R. G. Harris's services, Dr. Ponder assumed charge and carried forward the multifarious activities of the laboratory without interruption. He organized and carried through the five symposia on excitation phenomena, internal secretions, the protein molecule, biological oxidations and permeability, the results of which, so far as published, have met with unstinted praise.

Dr. Millislav Demerec, of the Department of Genetics, Carnegie Institution of Washington, was elected director of the laboratory for the year 1941. Dr. Kenneth S. Cole, of the College of Physicians and

Surgeons of New York City, and Dr. G. W. Corner, of the Carnegie Institution, were elected to the board, and the latter to the chairmanship of the Scientific Advisory Committee, Arthur W. Page, under whose presidency the association's activities were developed to a high degree, having resigned due to pressure of other duties, Dr. Robert Cushman Murphy, of the American Museum of Natural History, was elected to succeed him as president of the association.

MEDALISTS OF THE ROYAL SOCIETY

KING GEORGE has approved the recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows:

To Professor P. M. S. Blackett, F.R.S., for his studies of cosmic rays and the showers of particles which they produce, for his share in the discovery of the positive electron, for his work on mesons and many other experimental achievements.

To Dr. F. H. A. Marshall, F.R.S., for his contributions to the physiology of animal reproduction.

The following awards of medals have been made by the president and council of the society:

The Copley Medal to Professor P. Langevin, For. Mem. R.S., for his pioneer work in the electron theory of magnetism, his fundamental contributions to discharge of electricity in gases and his important work in many branches of theoretical physics.

The Rumford Medal to Professor K. M. G. Siegbahn for his pioneer work in high precision x-ray spectroscopy and its applications.

The Davy Medal to Professor H. C. Urey for his isolation of deuterium, the heavy hydrogen isotope, and for his work on the use of this and other isotopes in following the detailed course of chemical reactions.

The Darwin Medal to Professor J. P. Hill, F.R.S., for his contributions to problems bearing on the interrelationships of the main groups of the Mammalia and on the phylogenetic history of the Primates.

The Sylvester Medal to Professor G. H. Hardy, F.R.S., for his important contributions to many branches of pure mathematics.

The Hughes Medal to Professor A. H. Compton for his discovery of the Compton effect, and for his work on cosmic rays.

SCIENTIFIC NOTES AND NEWS

SIR HENRY DALE, director of the National Institute for Medical Research, London, has been elected president of the Royal Society.

WILLIAM BENJAMIN GREGORY, professor emeritus of experimental engineering and hydraulics at Tulane University and consulting engineer, was presented with the Worcester Reed Warner Medal at the sixty-first annual meeting of the American Society of Mechanical Engineers. This medal is awarded annually for contributions to permanent engineering literature. It is named in memory of W. R. Warner, co-founder of The Warner and Swasey Company, who was a charter member of the society and its president in 1897. Its establishment was made possible by a provision in Mr. Warner's will.

DR. WILLIAM CROCKER, director of the Boyce Thompson Institute of Plant Research and president of the Yonkers Board of Education, was the guest of honor on December 2 at a dinner in the City Club, tendered him by the members of the Yonkers Inner Circle, which has designated him as the outstanding citizen of Yonkers.

FRANCIS C. FRARY, director of research for the Aluminum Corporation of America, was elected president of the American Institute of Chemical Engineers at the New Orleans meeting. He succeeds Dr. Webster N. Jones, of Pittsburgh. Sidney D. Kirkpatrick was elected vice-president, Stephen L. Tyler was re-elected executive secretary, and Carl R. DeLong was reelected treasurer.

THE following officers of the New York Academy of Medicine were elected on December 5: *President,* Dr. Malcolm Goodridge, professor of clinical medicine at the Cornell University Medical College; *Vice-president,* Dr. Henry Cave, assistant professor of surgery, Columbia University; *Trustees,* Drs. George Baehr and Arthur F. Chace; *Members of Committee on Library,* Drs. Alfred E. Cohn, Howard R. Craig and Jerome P. Webster; *Members of Committee on Admission,* Drs. J. William Hinton, John E. Scarff, William E. Studdiford and Edward Tolstoi.

OFFICERS of the American Pharmaceutical Association have been elected as follows: *President-elect,* B. V. Christensen; *First Vice-president,* J. K. Attwood; *Second Vice-president,* L. W. Rowe; *Members of the Council,* R. L. Swain, P. H. Costello and F. E. Bibbins. The next annual meeting of the association will be held in Detroit from August 17 to 23.

WALTER L. WIRTH, superintendent of parks of New Haven, Conn., was elected president of the American Institute of Park Executives at the recent Cleveland meeting.

IT is reported in *Nature* that at the annual statutory meeting of the Royal Society of Edinburgh, held on October 28, the following officers were elected: *President,* Professor E. T. Whittaker; *Vice-presidents,* Dr.

Leonard Dobbin, J. A. Inglis, Professor R. Stockman, Professor James Ritchie, Dr. G. W. Tyrrell and Professor C. T. R. Wilson; *General Secretary,* Professor James P. Kendall; *Secretaries to the Ordinary Meetings,* Professor R. J. D. Graham and Professor W. M. H. Greaves; *Treasurer,* Dr. E. M. Wedderburn; *Curator of the Library and Museum,* Dr. J. E. Mackenzie.

CHARLES JOSEPH TILDEN, since 1919 Strathcona professor of engineering mechanics at Yale University, has retired with the title of professor emeritus.

THE Council of National Defense, composed of six cabinet members—the Secretaries of War, Navy, Interior, Agriculture, Commerce and Labor, has appointed Paul V. McNutt, Federal Security Administrator, coordinator of "all health, medical welfare, nutrition, recreation and other related fields of activity affecting the national defense."

DR. EUGENE F. DUBOIS, professor of medicine at the Cornell University Medical College, has been appointed chairman of the sub-committee on clinical investigation of the National Research Council. This committee reviews problems submitted by the Surgeon Generals of the United States Army and Navy.

MEMBERS of the faculty of the University of California who will devote part of their time to scientific research on mechanisms and devices of warfare include Dr. Ernest O. Lawrence, professor of physics and director of the Radiation Laboratory at the university at Berkeley; Dr. Donald Cooksey, assistant director of the laboratory, and Dr. Vern O. Knudsen, professor of physics at Los Angeles, and Dr. William Crowell Bray, Dr. William F. Giauque and Dr. Wendell M. Latimer, of the department of chemistry at Berkeley.

DR. HERMON CAREY BUMPUS has resigned as chairman of the Educational Advisory Board of the National Park Service. He is succeeded by Edmund H. Abrahams, of Savannah, Georgia.

DR. ROBERT A. STEWART, who obtained the degree of doctor of philosophy in agricultural biochemistry at the Pennsylvania State College in August, has been appointed biochemist with the Quaker Oats Company, Chicago.

DRS. E. RUFFIN JONES, JR., and Frederick F. Ferguson, of the Norfolk Division of the College of William and Mary and the Virginia Polytechnic Institute, have recently received a grant from the American Association for the Advancement of Science through the Virginia Academy of Science, to assist in their work on the Turbellaria of the Norfolk area.

DR. ARTHUR L. DAY, who retired in 1936 as director of the Geophysical Laboratory of the Carnegie Institution of Washington, lectured before the department of geology of the Ohio State University on the afternoons of December 2 and 3 and before the Society of the Sigma Xi of the university on the evening of December 3. The subjects of the lectures were "Geysers," "Hot Springs and Volcanism" and "The Hot Springs of New Zealand and Yellowstone Park."

DR. A. BAIRD HASTINGS, professor of biological chemistry in the Harvard Medical School, will deliver on December 19 the third Harvey Society Lecture of the current series at the New York Academy of Medicine. He will speak on "The Electrolytes of Tissues and Body Fluids."

DR. G. H. PARKER, of Harvard University, spoke on December 5 at the University of New Hampshire on "A Modern View of the Action of the Nervous System." The address was given under the auspices of the Graduate Science Society as a part of the celebration of the seventy-fifth anniversary of the founding of the University of New Hampshire.

DR. S. R. DETWILER, professor of anatomy at Columbia University, gave on November 25 at the University of Alabama a lecture, under the auspices of the Alabama Chapter of Sigma Xi, on the "Biological Aspects of Vision."

DR. ROSS A. MCFARLAND, assistant professor at the Fatigue Laboratory of Harvard University, gave a lecture on November 8 to a joint meeting of the Union College chapters of Phi Beta Kappa and Sigma Xi on "The Psycho-physiological Effects of High Altitude on the Human Organism." Before the lecture, President Dixon Ryan Fox, of Union College, addressed the societies at a dinner at Hale House.

DR. KARL EVANG, director of public health of the Royal Norwegian Government, gave a lecture on December 9 at Swarthmore College under the auspices of the department of zoology. He spoke on "Problems of Nutrition in Norway Before and After the German Invasion."

THE twenty-ninth annual meeting of the Oklahoma Academy of Science opened at the University of Oklahoma on December 6 under the presidency of Dr. G. L. Cross, head of the department of botany. Dr. George T. Moore, director of the Missouri Botanical Garden, St. Louis, was the principal speaker. His address was entitled "On Being Scientific."

IN conjunction with the medical sessions of the American Association for the Advancement of Science at Philadelphia a discussion on biochemistry and physiology in relation to mental disease will be held on Tuesday, December 31, at 2 P.M., in the auditorium of the Institute of the Pennsylvania Hospital. Dr.

Nolan D. C. Lewis will be chairman, and various aspects of the subject will be discussed by Drs. Detlev W. Bronk, Ernst Gellhorn, R. W. Gerard, Harold E. Himwich, Hudson Hoagland and S. Bernard Wortis. Besides discussion of the papers it is hoped that there will be time for short reports by others present. Those wishing to present such a report should inform Dr. Lewis or Dr. Elliott before the meeting.

ALL meetings of the British Astronomical Association have been postponed until further notice.

THE International Association for Dental Research celebrated on December 10 its twentieth anniversary at the St. Moritz Hotel, New York. Wilmer Souder, of the National Bureau of Standards; Dr. William J. Gies, of Columbia University, president and founder of the association, respectively, and Brigadier General L. C. Fairbanks addressed the meeting.

IT is announced that requests to the National Research Council Committee for Research in Endocrinology for aid during the fiscal period from July 1, 1941, to June 30, 1942, will be received until January 31. Application blanks may be obtained by addressing the Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, Washington, D. C. In addition to a statement of the problem and research plan or program, the committee desires information regarding the proposed method of attack, the institutional support of the investigation and the uses to be made of the sum requested. No part of any grant may be used by the recipient institution for administrative expenses. Applications for aids of endocrine research on problems of sex in the narrower sense can not be given favorable consideration, but the committee will consider support of studies on the effects of sex hormones on non-sexual functions—*e.g.*, on metabolism.

THE Board of Directors of the Josiah Macy, Jr. Foundation, founded by Mrs. Walter G. Ladd in memory of her father, held on November 19 its annual meeting making the tenth anniversary of the official operation of the foundation. Two new members were elected: Clarence G. Michalis and Nelson Macy, Jr. Other members of the board are Robert E. Allen, S. Bayne-Jones, Charles S. Burwell, John Dewey, Harry Emerson Fosdick, Ludwig Kast, Dave H. Morris, Lawrence Morris, Willard C. Rappleye, Dean Sage, Paul H. Smart, Edwin S. S. Sunderland and Samuel Trexler. The following officers were elected: the Honorable Dave H. Morris, *Chairman of the Board;* Dr. Ludwig Kast, *President;* Robert E. Allen, *Treasurer,* and Edwin S. S. Sunderland, *Secretary.* Other officers of the foundation are Lawrence K. Frank, *Vice-president,* and Dr. Frank Fremont-Smith, *Director of the Medical Division.* At the meeting the sum of $50,000 was appropriated in support of research bearing on health problems affecting national defense. Last year $135,000 was appropriated, and during the entire period of ten years, the sum of $1,500,000 has been granted to institutions in the United States and in other countries for research in the field of medicine and health care. Support of work in foreign countries, owing to the international situation, was discontinued a year ago.

NORTHWESTERN UNIVERSITY has received $635,000 from the estate of the late Dr. John S. Appleman. Of this sum $135,000 is restricted to the use of the clinics of the Medical School. A gift of $162,000 has also been received from the Clara A. Abbott trust for the advancement of medical, chemical and surgical science.

AN agreement was signed on December 3 between New York City and the American Museum of Health for the establishment of a permanent health museum in the Medicine and Public Health Building on the grounds of the New York World's Fair in Flushing Meadow Park. Dr. Louis I. Dublin, chairman of the board of the American Museum of Health, and Park Commissioner Robert Moses signed the contract, which provides that the museum will coordinate policies with the Department of Health and the Board of Education to provide instruction in matters of public health. Alterations to the existing structure will be completed on May 1. The American Museum of Health was incorporated in 1937 with George McAneny as president; Frederick Osborn, vice-president, and Sam A. Lewisohn, treasurer. Homer N. Calver will be in charge of the museum.

OWING to reduction in income and shortage of paper, the Scottish *Geographical Magazine* has been compelled to reduce its size and the number of issues per annum. It is hoped to publish annually three issues of forty-eight pages each. It was also found necessary to dispense with the services of a paid editor. J. F. Stewart, a member of the council of the society, has undertaken the honorary editorship in the meantime.

DISCUSSION

COLLECTING PELAGIC FORAMINIFERA

DURING the last few years rather intensive work in submarine geology has been conducted at the Woods Hole Oceanographic Institution under the direction of Henry C. Stetson. In connection with this work study of the Foraminifera contained in the bottom sediments

taken from the western North Atlantic has been undertaken by Dr. Joseph A. Cushman, Miss Frances L. Parker and the writer. The immediate purpose of this study has been twofold: first, to determine the distributions, according to depth, temperature, etc., on the continental shelf and slope; and second, to use these data as a yardstick in interpreting environments represented by faunas occurring in sediments of submarine cores and tows. This latter applies directly to the Pleistocene history of the North Atlantic. Another purpose in pursuing such a study is that the data obtained on foraminiferal ecology may be used in interpretation of certain marine sediments of Cretaceous and Cenozoic age.

In submarine cores collected from the continental slope and basin of the western North Atlantic there occurs a fauna of Arctic type, beneath the warm temperate fauna occurring in the sediments at the surface of the ocean bottom. This Arctic fauna is of Pleistocene age and represents different oceanic conditions than those obtaining to-day. In order to interpret accurately the environmental conditions represented by such a series of faunas found in the cores it is necessary to know the ecologic conditions under which the animals live. It is known from the records of the expeditions of the *Challenger, Meteor* and others, that certain species are pelagic in habitat, particularly of the families Globigerinidae and Globorotalidae. It is generally assumed that all other species are bottom-living, and in the case of species having arenaceous tests this must certainly be true. Relatively little other pertinent information appears to have been recorded.

The impression that living pelagic Foraminifera are now rare or almost absent in the waters of the western North Atlantic seems to have gained headway in recent years. This is due to the fact that they have not been observed to occur in plankton tows, especially in the experience of the biologists at the Woods Hole Oceanographic Institution who are doing intensive work on the plankton from the area in question. It is true that most of this plankton is being collected for other purposes and the nets are too coarse to retain Foraminifera. Moreover, preservation of plankton in formalin dissolves the calcium carbonate tests of Foraminifera, due to the acid nature of this preservative. The procedure used in the treatment of phytoplankton, which is collected in fine mesh nets, is even more radical in the use of acid, and under these conditions no calcium carbonate test could possibly survive solution.

During a short cruise of the research ship *Atlantis* made during the early part of August, 1940, the writer successfully collected Foraminifera in zooplankton tows. The tows came from the surface waters above the upper half of the continental slope between north latitudes 37 and 39 degrees. Four samples were taken with fine mesh silk nets of the type ordinarily used for the collection of diatoms (about 150 strands to the inch) at depths of 30, 40 and 50 meters at noon, early evening, midnight and early morning. The content of Foraminifera was relatively small in proportion to the amount of plankton obtained, being a maximum of about 100 specimens in approximately 5 cc of plankton. This material was placed in a 70 per cent. solution of alcohol, which coagulates the protoplasm and does not affect the calcareous test. In the laboratory the material was examined suspended in water after the sample had been washed and the amount of fluid reduced to a minimum.

The species obtained in these tows are *Globigerinoides rubra, G. sacculifera, G. aequilateris, Globigerina bulloides, G. inflata, G. dubia* and *Orbulina universa. Globigerinoides rubra* was by far the most common species, and several specimens of this species retained long, delicate spines protruding from the test (never preserved in bottom samples), in many cases the length of these spines is about three times the diameter of the test. In a great many the coagulated protoplasm was observed protruding from the aperture or partially surrounding the test. In other cases the protoplasm was discovered inside the test after breaking the shell with a dissecting needle. The specimens of *Globigerina dubia* were reddish brown in color; some of these were mounted in tragacanth glue and were white when dry.

Using this technique it will be possible to check the vertical and areal distribution of pelagic Foraminifera and a beginning on this work in the western North Atlantic is planned for the near future. Quantitative and seasonal collecting should give data on the present rate of accumulation of foraminiferal deposits in bottom sediments. These are some of many problems pertaining to the general ecology of the Foraminifera which need extensive study.

FRED B. PHLEGER, JR.
WOODS HOLE OCEANOGRAPHIC INSTITUTION

ON THE SPECIFICITY OF RENIN

IT has been found that by the action of the kidney protein renin on a blood globulin a thermostable pressor substance is formed (angiotonin[1]), or hypertensin.[2, 3, 4] Crystalline derivatives of this substance

[1] I. H. Page and O. M. Helmer, *Jour. Exp. Med.*, 71: 29, 1940.
[2] E. Braun-Menendez, J. C. Fasciolo, L. F. Leloir and J. M. Muñoz, *Rev. Soc. Arg. Biol.*, 15: 420, 1939.
[3] J. M. Muñoz, E. Braun-Menendez, J. C. Fasciolo and L. F. Leloir, *Nature*, 144: 980, 1939.

are reported to have been obtained by Page and Helmer.[1]

Renin is secreted by ischemic kidneys,[5, 6] and hypertensin is afterwards formed in the blood.[2, 4] Renin is presumably an enzyme and does not act directly on blood vessels but by the intermediation of hypertensin. The hypertensin-precursor in blood was found to increase after nephrectomy and to decrease or disappear after the injection of renin. This fact suggests that there is a slight renin production by normal kidney. Such a production of renin also explains the rise in blood pressure obtained by Govaerts and Muller[7] by grafting normal kidneys to nephrectomized dogs.

While the pressor substance was found to be formed by the action of swine renin on the sera of horse, swine, cattle or dog, none was formed with human serum. When, however, human renin was used, hypertensin was formed with the serum of any of the above species.

This peculiar specificity of renin leads to the prediction that no pressor response should be obtained in man when swine renin is injected intravenously. Our experience, while limited to sick men, came to confirm this prediction, although hypertensin injected intravenously to the same subjects caused a rise in blood pressure. Since other investigators may have tested this action we are eager to know of further confirmatory evidence.

JUAN CARLOS FASCIOLO
LUIS F. LELOIR
JUAN M. MUÑOZ
EDUARDO BRAUN-MENENDEZ
UNIVERSITY OF BUENOS AIRES,
JUNE 11, 1940

EXCHANGE PERIODICALS FROM FOREIGN COUNTRIES

THE note in SCIENCE, Vol. 92, November 15, page 452, from the Engineering Societies Library, in regard to the receipt of exchange periodicals from foreign countries (not including the American continents) and the statement that that library has made arrangements to store the periodicals in the country of origin until the end of hostilities, is of great interest to the library of the Marine Biological Laboratory. But is not this decision, asking that all countries that are at war hold their exchange material until hosilities have ceased, somewhat unnecessary at the present time when, as is the case for this library, periodicals from England, Ireland, Wales, Scotland, Australia, Indo-China, China, Tahiti, South Africa, Dutch Indies, India, Egypt, Syria, Newfoundland, Morocco, Portugal, Japan and Siberia are still coming through regularly, though somewhat delayed, and even a few German periodicals are now arriving again by way of Siberia and Japan? The fact that so many countries are able to get their publications through to us has encouraged this library to take a more opportunistic attitude by not stopping in all cases the shipment of exchange material destined for us. This library has asked all its exchange institutions in countries on the continent of Europe to hold their publications but has not as yet made this request to the other countries mentioned above in the hope that the necessity for this may not arise. If and when the necessity arises, a request to have the publications held back will be sent. This is more troublesome and perhaps entails risk, but it appeals to us as a practical method. The above has no reference to the *paid subscriptions* held by this library in foreign countries outside of the Americas, but, in general, the same method for securing the subscriptions continuously or at a later date has been applied.

PRISCILLA B. MONTGOMERY

ANTIQUE GALENICALS

WHILE our British colleagues are deserving of deep sympathy and commiseration in these dark days, one can not feel sorry about their difficulties in obtaining buchu leaves, seneca root, jalap, krameria, galsemium seed, black catechu, aconite, and calumba root, as noted in SCIENCE, October 25, p. 373. Why such antique galenicals are still used by British physicians is hard to understand unless it be on the basis of steadfast British tradition. It seems that if this war has no other good effect, it may at least serve to modernize some features of British therapeuties.

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SCIENTIFIC BOOKS

MATHEMATICAL PAPERS OF SIR WILLIAM ROWAN HAMILTON

The Mathematical Papers of Sir William Rowan Hamilton, Vol. 2, Dynamics. Edited by A. W. CONWAY and A. J. MCCONNELL. xv + 656 pp. Cambridge: Cambridge University Press. New York: Macmillan. 1940. 50 sh.

THIS impressive book is the second volume of Hamilton's collected papers, the first volume of which

[4] E. Braun-Menendez, J. C. Fasciolo, L. F. Leloir and J. M. Muñoz, *Jour. Physiol.*, 98: 283, 1940.

[5] K. G. Kohlstaedt and I. H. Page, *Proc. Soc. Exp. Biol. and Med.*, 43: 136, 1940.

[6] L. F. Leloir, J. M. Muñoz, E. Braun-Menendez and J. C. Fasciolo, *Rev. Soc. Arg. Biol.*, 16: 75, 1940.

[7] P. Govaerts and P. Muller, *C. R. Soc. Biol.*, 131: 1311, 1939.

appeared in 1931. It is devoted to the subject of dynamics and so contains that part of Hamilton's work which many students estimate as the most important of his amazing contributions to knowledge. With the exception of a few minor notes, occupying less than ten pages of the present volume, Hamilton's work on dynamics was done over one hundred years ago during the decade 1830–40. It is only now after the lapse of a century, largely due to the physical successes of the theory known as wave-mechanics, that it is accorded the general recognition that its importance deserves. It is for the present reviewer a striking and welcome coincidence that Schrödinger, the founder of the theory of wave-mechanics, is now a professor at the Royal Irish Academy of which Hamilton has been the most distinguished president. The interest of the volume under review is much enhanced by the fact that more than half of it (over 300 pages) has not previously been published.

It would be out of place, even if space permitted, to attempt to give any detailed account of the contents of Hamilton's papers on dynamics. However, as in most mathematical theories, the important central idea may be described so as to be understandable by any interested, intelligent scientist. The simplest mechanical system consists of a material particle moving in some field of force (say the gravitational field of the earth) and the problem of its motion may be looked at from two quite different viewpoints. We may regard as given the conditions at the start (*i.e.*, the initial position and the initial magnitude and direction of the velocity) and may ask the conditions at some later time; or we may regard as given the initial position and the position at some later instant and may ask the initial magnitude and direction of the velocity. For convenience of reference we term the first point of view the local or differential view-point and the second point of view the ballistic or distant view-point (it being in fact the point of view of a gunner who wishes to hit a distant object). Hamilton's great merit was the emphasis he laid on the ballistic point of view (which led to his discovery of his Principal Function) as opposed to the local point of view which had dominated his great predecessor Lagrange. Once the importance of the Principal Function (which is determined by the initial and final positions of the particle) is realized, the theory of partial differential equations assumes full sway; and the interplay between this theory and the theory of ordinary differential equations (in which the time is the independent or master variable) which dominates the local point of view constitutes the important core of Hamilton's work (which was later perfected by Jacobi). The subsequent development of the Calculus of Variations (which occupies a central position in physical theories) may be largely attributed to Hamilton's work. It is pleasant to be able to say that credit for the recent important developments in this theory must be assigned to American mathematicians (particularly Bliss and Morse). Indeed, one need only point to Birkhoff's work in dynamics and to Morse's emphasis on the "large" as opposed to the "local" point of view, to justify the statement that Hamilton's mantle has fallen upon American shoulders. In this connection we must not forget the important work of Synge (who assisted in editing the first volume of Hamilton's works) on the subject of Hamilton's optical researches.

The physical appearance of the book leaves nothing to be desired. That it could be produced at all in the present difficult times is a real tribute to its publishers. The world of science owes a great debt to the editors, both for their clarifying appendices and for their intelligent restraint.

F. D. MURNAGHAN
THE JOHNS HOPKINS UNIVERSITY

RECENT DEVELOPMENTS IN THE STUDY OF ROCKS

A Handbook of Rocks for Use without the Petrographic Microscope. By JAMES FURMAN KEMP, sixth edition, completely revised and edited by Frank F. Grout. viii + 300 pp. New York: D. Van Nostrand Company. 1940. $3.00.

THIS excellent revision of Kemp's well-known book follows much of the plan of the older editions but has been largely rewritten so as to take account of the recent developments in the study of rocks. One who is familiar with the older editions notices that the rather detailed discussion of the chemistry included in the descriptions of the rocks in the older editions has been wisely abridged and assembled in a separate section. The glossary which was very valuable in the old editions has been omitted. Several such glossaries are now available.

This book gives excellent hand specimen classifications and descriptions of the igneous, sedimentary and metamorphic rocks; good brief discussions of the field occurrence, geological relations, and origin of such rocks; and descriptions of the newer methods of study. It includes a chapter on calculations in rock study, and illustrations of rock descriptions.

Much of the text is devoted to the naming and descriptions of rocks, and the classifications adopted are simple but are very well suited to megascopic work by one who is not a professional petrographer. An experienced petrographer can make finer megascopic distinctions and must do so to carry on precise petrographic field work. The sections on the origins of rocks, the relations of rocks to each other, sedimentation, and metamorphism are brief but clear discus-

sions of the subjects and are very well selected to give the student an elementary knowledge of our present views on them.

The book should be very valuable to mining engineers, geologists, and others who are interested in making careful studies of rocks without using the petrographic microscope. It is an excellent text-book for courses in macroscopic petrography.

ESPER S. LARSEN

HARVARD UNIVERSITY

SOCIETIES AND MEETINGS

THE AUTUMN GENERAL MEETING OF THE AMERICAN PHILOSOPHICAL SOCIETY

AN unusual number of important scientific meetings have been scheduled to be held in Philadelphia this fall and winter. Among these were first and foremost the notable Bicentennial Celebration of the University of Pennsylvania with its numerous sections, sessions, lectures and symposia, the semi-annual meeting of the National Academy of Sciences and the annual meeting of the American Association for the Advancement of Science with its many affiliated and associated societies. Under these circumstances, it was feared that the regularly held Autumn Meeting of the American Philosophical Society might not be well attended nor of real importance. But this fear was not justified, for about seventy-five members of the society and one hundred guests, many of them from distant places, were in attendance at the meeting on November 22 and 23. There were three half-day sessions for the reading of papers at which twenty papers were presented, twelve of them by recipients of grants from the research funds of the society. Most of these papers were discussed by persons who were familiar with the subjects presented and the sessions were of correspondingly increased interest. The list of speakers, their topics and the leaders in the discussion of each paper were as follows:

H. P. Robertson, professor of mathematical physics, Princeton University. "Stationary Stellar Systems." Discussed by Dr. Shapley.

K.Aa. Strand,* research associate, Sproul Observatory, Swarthmore College. "The Orbital Motion of Zeta Aquarii." Discussed by Mrs. Gaposchkin.

W. F. G. Swann, director, Bartol Research Foundation of the Franklin Institute. "The Origin of the Secondary Peak in the Rossi Curve for Tin."

S. A. Korff,* research fellow, Bartol Research Foundation of the Franklin Institute; research associate, Carnegie Institution of Washington. "The Production of Neutrons by the Cosmic Radiation." Discussed by Dr. Swann.

Henry A. Boorse,* assistant professor of physics, Columbia University (Barnard College). "Some Problems of Low Temperature Physics." Discussed by Drs. Swann, Aydelotte and Urey.

Oswald Veblen, professor of mathematics, Institute for Advanced Study. "Report on *Mathematical Reviews.*"

Franz Boas, professor emeritus of anthropology, Columbia University. "Relation between Physical and Mental Development." Discussed by Dr. Davenport.

Daniel Sutherland Davidson,* assistant professor of anthropology, University of Pennsylvania. "Rock Paintings and Carvings in Western Australia." Discussed by Dr. Kidder.

Mary Butler,* research associate, University Museum, University of Pennsylvania. "An Archeological Survey of the Alta Verapaz, Guatemala." Discussed by Dr. Kidder.

L. S. Cressman,* professor of anthropology, University of Oregon; John Simon Guggenheim Memorial Foundation Fellow, 1940–41. "Studies on Early Man in South Central Oregon."

Edith von Porada,* research fellow, John Pierpont Morgan Library. "The Collection of Cylinder Seals in the Pierpont Morgan Library."

Nelson Glueck,* professor of bible and biblical archeology, Hebrew Union College. "Ezion-geber: Solomon's Seaport." Discussed by Dr. Albright.

T. Leslie Shear, professor of classical archeology, Princeton University. "Résumé of Results of Ten Years' Excavation in the Athenian Agora." Discussed by Dr. Meritt.

A. P. Coleman, lecturer in East European languages, Columbia University. (Introduced by Dr. Prince.) "Sir John Bowring and Slavonic Poetry." Discussed by Dr. Conklin.

William B. Scott,* professor emeritus of geology and paleontology, Princeton University. "The Mammalian Fauna of the White River Oligocene." (Read by title.)

Glenn L. Jepsen, associate professor of geology, Princeton University. (Introduced by Dr. W. B. Scott.) "The Ancestry of the 'Flying Lemur.'" Discussed by Drs. Shull and Conklin.

William J. Robbins,* professor of botany, Columbia University; director, New York Botanical Garden. "Vitamin B_6 and Growth of Excised Tomato Roots." Discussed by Drs. Bronk and White.

Charles B. Davenport, director (retired), department of genetics, Carnegie Institution of Washington. "Responsive Bone." Discussed by Drs. Weiss and Corner.

Alexander Weinstein,* Zoological Laboratory, Columbia University. "The Geometry and Mechanics of Crossing Over." Discussed by Drs. Whiting and Conklin.

Paul Weiss,* associate professor of zoology, University of Chicago. "Autonomous vs. Reflexogenous Activity of the Central Nervous System." Discussed by Dr. Bronk.

Leonard G. Rowntree,† director, Philadelphia Institute for Medical Research. "The Work of the Philadelphia Institute for Medical Research."

The evening lecture on November 22 was given by Edward S. Corwin, professor of jurisprudence,

* Recipient of grant from the Penrose Fund.

† Recipient of grant from the Deland Fund.

Princeton University, on "Some Aspects of the Presidency"—a timely and scholarly address on the development of the powers and functions of the President during our national history.

As usual, the social aspects of the meetings of the society were not neglected. All out-of-town members and speakers were guests of the society at the Benjamin Franklin Hotel. An informal dinner preceded the lecture on Friday evening and a reception followed it. Luncheons were served in the Hall of the society on each day of the meeting and, as usual, there were many assurances that the meetings of the American Philosophical Society are the most enjoyable of all.

The whole of Saturday afternoon was given up to an executive session of the society. In addition to regular business a report was made by Mr. W. Stephen Thomas, executive secretary of the committee on education and participation in science on its work during the past year. This work is carried on under the auspices of the American Philosophical Society and with funds furnished by the Carnegie Corporation of New York. It is an attempt to stimulate work in science by amateurs and to cultivate in them scientific habits of thought and work. Philadelphia was thought to be a particularly favorable place to experiment in this field of education because of its long history of amateurs in science and its many clubs and organizations of amateur scientists. A survey has been made by Mr. Thomas which shows that there are in Philadelphia 287 clubs and societies of amateurs, with 32,000 members, in pure and applied sciences. The facts of this survey have been printed in a pamphlet of 44 pages entitled "The Layman Scientist in Philadelphia: A Directory of Amateur Scientific Organizations and Resources in Science" by W. Stephen Thomas.

The committee has also organized four projects in which amateurs may participate in scientific work under the direction of four scientific consultants; these are (1) a project in botany, planned and supervised by Dr. John M. Fogg, Jr., on the blooming and fruiting of native wild plants, with tabulations of dates and weather conditions on charts provided by the supervisor and filled out by the volunteer observers. More than 200 charts were distributed to applicants and 51 have been returned with data on some 85 species. (2) Radio project for amateurs to determine facts concerning the ionosphere through records of radio reception, fade-outs and skip-distance occurrences. Dr. Serge A. Korff planned and supervised this project and prepared a form or log to be filled out by observers. About 200 persons applied for these logs and to date 50 persons have actively cooperated in filling out over 200 of these charts. These observations have been so planned that they provide an important supplement to the work of professional students of radio. (3) A third project for amateur cooperation in science concerns the study of the annual rings of old trees in the Delaware Valley with a view to the correlation of tree ring growth with climatic conditions and records of the weather. This project was proposed and is guided by Dr. E. E. Wildman and several hundred persons are cooperating in studying the rings of stumps and logs of old trees and timbers from ancient buildings. One hundred persons have already reported on such studies submitting charts of the rings or in some cases sections of the trees themselves. (4) Finally, Mr. Roger Conant, of the Philadelphia Zoological Garden, has organized a project for tagging frogs, turtles and snakes and a few singing insects, so that their habits, life histories and migrations may be better known. To date 52 persons have participated in this project and have done careful work and kept excellent records.

A monthly bulletin has been published by this committee and distributed to a large number of interested persons. Numerous meetings of members of the executive staff with various clubs and organizations have occurred; a council composed of several of these organizations has been formed and several meetings held in the Hall of this society. It was the general opinion of those who heard this report that the committee on education and participation in science has made a good beginning on an important project.

In reviewing the society's support of research during the past seven years, Dr. Conklin, chairman of the committee on research, reported that the total sum assigned to research from the Penrose Fund during these years was nearly $475,000, or an average of nearly $68,000 a year. In addition the accumulated income of the Johnson Fund, all of which is assigned to research, has amounted to about $47,000 and during the past three years the research grants from this fund have averaged $13,000 each year. The available income from the Daland Fund for research in clinical medicine has since its reception in 1938 amounted to about $18,000 or $6,000 each year. Thus the total research budget of the society is now about $87,000 a year. The research budget from the Penrose Fund is unrestricted, that from the Johnson Fund is semi-restricted in that it has been agreed that persons working in certain institutions may be regarded as occupying a preferred position, while the income from the Daland Fund is restricted to research in clinical medicine and one institution has for the time being been given a preferred position.

A tabular summary of the research grants made from the Penrose Funds shows that since the beginning of our research program in mid-summer 1933 there have been 485 grants in 32 different subjects for a total sum of $446,882, or a general average of more

than $920 per grant. In Class I, Mathematical and Physical Sciences, 135 grants were made in six different subjects for a total sum of a little more than $140,000; Class II, Geological and Biological Sciences, received 236 grants in fourteen different subjects for a total sum of $182,476; Class III, Social Sciences, received 26 grants in history and political science for a total of $20,632; Class IV, Humanities, received 81 grants in nine different subjects totaling $84,713. In addition to the 478 grants in these four classes there were seven miscellaneous grants, which could not be properly classified in any of the classes, for a total sum of a little more than $19,000.

In explanation of the inequality of distribution of research funds to the four classes it was pointed out that this distribution was roughly proportional to the number of applications from these classes; furthermore the committee on research has always attempted to make the grants to the most worthy applicants without reference to the classes or subjects represented.

The funds at the disposal of the Committee on Research are not sufficient to make long-continuing grants and consequently the policy has been to help start or finish worthy projects rather than to furnish continuing support; in only 68 cases have grants been renewed for a second time and only in 23 cases for a third. Likewise, it has not been possible to make grants to pay in whole or in part the salaries of members of the staff of any institution, nor in general to pay living expenses of applicants.

In all cases applicants are expected to specify the uses to which the grant will be put. In general each grant has been used for several purposes, but the principal uses may be classified as follows: assistants, technical, artistic, etc., 213 grants; apparatus and materials, 128 grants; travel and field work, 123 grants; living expenses, 14 grants, and publication, 6 grants.

Recipients are notified that in no case is a grant to be regarded as a gift or charity but rather as an investment in men and projects, which investment is expected to yield returns. No doubt there are many returns of a more or less intangible nature such as the personal education of the recipient, but the most tangible result of any grant is the promotion of knowledge through the publication of research. All grantees agree to furnish an abstract of the results of their researches for publication in the *Year Book* of the society. In *Miscellanea* for 1935 and 1936, there were published 25 such abstracts; in the *Year Books* for 1937, 1938 and 1939, 289 abstracts; and 47 full papers resulting from grants have been published in the *Proceedings* of the society, 6 in the *Transactions* and 3 in the *Memoirs;* while 118 reports of researches aided by grants of this society have been reported at its general meetings. In addition, grantees have reported 236 books and articles published elsewhere which have resulted in whole or in part from grants of this society. Thus practically all grants, except some of those made during the past year for which there has not been sufficient time to expect published results, are represented in these publications. In general this seems to be a fairly satisfactory return on the investments made in our grants-in-aid of research.

Twelve different members of the Committee on Research reported to the society their estimates of the value of the researches in the fields with which they were especially familiar, and as one member said of his own field they might be classed as good and not-so-good. This could probably be said of the grants in all the fields. It is difficult to say what proportion of all the researches could be classed as good, fair or poor, but it is probable that at least three quarters of all would fall in the first two categories. Perhaps this is as good a result as could be expected, considering the fact that the Committee on Research has been inclined to favor applicants who are in small institutions where facilities for research are not good. In all such cases the stimulus to investigator and institution has been an important result and the grant has been regarded as a trust and has been conscientiously used as such. On the whole it may be said that the research program of the American Philosophical Society has been a success and that our investments in men and projects have yielded satisfactory returns.

EDWIN G. CONKLIN

SPECIAL ARTICLES

SUGGESTIONS ON PLANT VIRUS NOMENCLATURE AS EXEMPLIFIED BY NAMES FOR CITRUS VIRUSES

SEVERAL systems of nomenclature for viruses have been advanced. The following suggestions have developed out of discussions with a number of my associates who have urged me to publish it for consideration. The following manner of naming the viruses, in my judgment, would combine the best features of Johnson's,[1] Smith's[2] and Holmes's[3] proposals, without the chief objections and difficulties in the application

[1] James Johnson, *Agr. Exp. Sta., Univ. of Wis. Res. Bull.* 76, 1927.

[2] Kenneth M. Smith, "A Textbook of Plant Virus Diseases," p. 101. Philadelphia: Blakiston Company, 615 pp., illus., 1937.

[3] Francis O. Holmes, "Handbook of Phytopathogenic Viruses." Minneapolis: Burgess Publishing Company, 221 pp., 1939.

and use of any one of these. It is virtually a simplified Smith's system without the confusion of numbers and Holmes's system without the generic difficulties. In view of our present imperfect knowledge we are not ready for genera in the ordinary concept.

A classification of submicroscopic entities, using many genera which are based merely on symptoms, is, it seems to me, of doubtful value in that it infers that we know more about these entities inducing these symptoms than we actually do know. It assumes certain close relationship between certain of these entities when, in fact, most of these relationships are still uncertain in general and in most cases totally unknown in any physical or chemical sense. On the basis of symptoms, the virus of psorosis in citrus could be placed in any one of four of Holmes's genera.

What seems at present most needed is an easily applied and simple rule for naming the viruses. In the flux of present research, significant names for use seem more important than systems of classification.

A simple way to accomplish this and combine the good features of the previously proposed methods is to use binomials as suggested by Bennett[4] but to derive the "genus" from the host plant, as do Johnson[1] and Smith,[2] and to use specific names, as does Holmes,[3] instead of numbers. In case viruses have already been described and tenable specific names have already been employed, these may be adopted.

The rule for the names of "genera," as indicated by examples given below, is plain, simple and easily applied. *Add the stem "vir" for virus (Latin neuter) to the Latin genitive of the genus of the host in which the virus was first discovered and recognized, dropping any final consonants that occur in this genitive.* To illustrate from viruses which have recently been named by Holmes, peach rosette virus becomes *Prunivir rosettae,* the raspberry-streak virus *Rubivir orientale,* the beet curly top virus *Betaevir eutetticola,* and potato yellow-dwarf virus becomes *Solanivir vastans.*

These "genera" tell one at once two things which are not evident in Holmes's genera: (1) that this "genus" refers to a virus as shown by the ending "vir" from the Latin virus; (2) that it was first recognized and shown by transmission to be a virus in a particular genus of plant. About the worst this rule can do is to make names like Medicaginivir or Chrysanthemivir, neither of which, however, is difficult to pronounce. It will also give many short names, as Zeaevir, Poaevir, Iridivir, Rosaevir, Pyrivir, etc. When the resulting "genus" might rarely have more than six syllables, the final syllable of the genitive may be dropped out. For example, for a new virus of Calceolaria, the derived generic name would be Calceolarivir instead of Calceolariaevir. All these may be considered as Latin neuter nouns.

Specific names of viruses already described may be added to such genera as far as these specific names are tenable, as indicated by the previously named examples. Some already proposed specific names in Holmes's system, however, may need to be replaced because of duplication that would otherwise result.

If authorities are to be cited for these virus names, these derived "genera pro tem" should not be considered in the ordinary taxonomic sense. Since these names are predetermined by the name of the host and since they carry their own meaning, necessary citations need be made only in relation to the names of species, as, for example, *Prunivir rosettae* Holmes[3] or *Prunivir rubiginosum* Reeves.[5] There would be no place for the term "new combination."

I suggest that no suspected virus be given a binomial name merely from observation of certain symptoms or effects in nature which resemble virus diseases until it has been conclusively proved that it is transmissible from plant to plant by budding, grafting, use of insect vectors, mechanical or other means.

Where there are well-marked distinct strains or varieties which need varietal names, these may follow the established botanical procedure. No varietal names, however, should be employed merely for virus strains showing more or less virulence or shownig more or less fluctuation in symptoms unless these produce other proven transmissible persistent differences that enable the virus varieties to be recovered again and recognized. To give varietal names based merely on observation of any of these slight differences in behavior will lead, it seems to me, to meaningless naming and confusion.

The advantages of this manner of naming would be:

(1) Simplicity and ease of application in our present imperfect knowledge of the viruses.

(2) Indication in the ending of the "genus" name that it is the name of a virus.

(3) Preservation in the name itself of the first-discovered host relationship of the virus, as in Johnson's and Smith's proposals.

(4) Avoidance of the confusion resulting from numbers, especially in the application of new numbers as is accomplished in Holmes's proposals.

(5) Avoidance of the implication of too certain a generic relationship between viruses producing certain similar host effects, pending more definite knowledge of these viruses.

(6) Furnishing immediate usage of definite predetermined "genera pro tem" which can be easily replaced without change of specific names by another set of genera, if need be, when sufficient knowledge of the viruses is forthcoming.

[4] C. W. Bennett, *Phytopathology,* 29: 422–430, 1939.

[5] E. L. Reeves, *Phytopathology,* 30: 789, 1940 (abst.).

In line with this manner of naming, the following designations are proposed for the citrus viruses:[6]

Citrivir italicum (italicum = pertaining to Italy). The virus causing infectious mottling of citrus.[7]

Citrivir psorosis (psorosis, Latin genitive of *psorosis* = of the psorosis disease). The virus causing psorosis of citrus.[8, 9]

C. psorosis var. *vulgare* (vulgare = general, common). The virus of psorosis A, or the common scaly bark type.[8, 9]

C. psorosis var. *anulatum* (anulatum = with a ring). The virus of psorosis B, a distinctly different type from A.[8, 10]

Other forms which are believed to be due to varieties of the psorosis virus pending further evidence are "concave gum," "blind pocket," "crinkly leaf" of lemon and "infectious variegation."

There are still other virus-like effects in citrus in which viruses are suspected but about which insufficient knowledge regarding transmission is known to justify virus names at present. Some of these are leprosis of Florida and South America, cyclosis of Brazil and concentric ring blotch of South Africa. In this connection it should be pointed out that there is no known experimental evidence to justify Atanosoff in listing as virus diseases a number of other things on citrus. To list certain effects as virus diseases merely because they have no known causal agent serves no useful purpose and tends to fill the literature with misleading erroneous citations.

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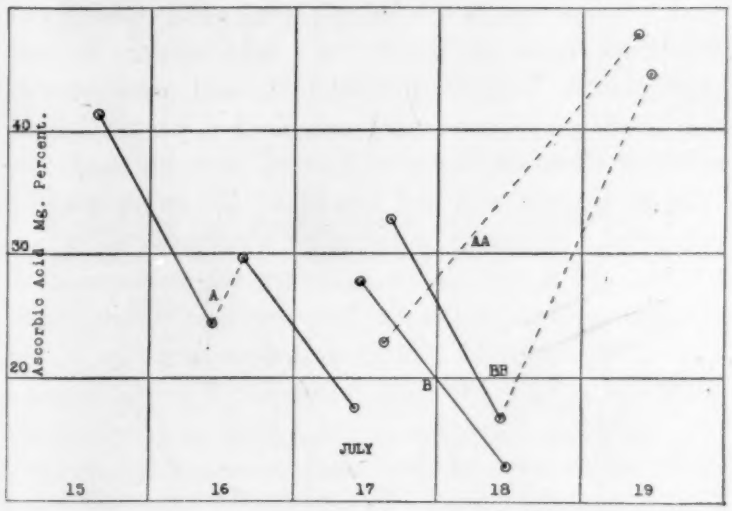
SOLAR RAYS AND VITAMIN C

IN an attempt to correlate the ascorbic acid content of young tomato plants of different varieties with the Vitamin C content of the tomatoes they produce, we have discovered a striking relationship between solar irradiation and ascorbic acid content in the plants.

Tomato seeds were planted on June 4, 1940; 24 plants of each variety transplanted into separate flats on June 14. They were kept in the greenhouse until June 26, when the flats were placed in the open. Five flats (Group A) were brought into the laboratory on July 15 and five additional flats (Group B) on July 17, for ascorbic acid studies. On Chart 1, graphs A and B represent the values when single whole plants, cut off at the ground (about 10 g), were used as samples. For graphs AA and BB the upper portions of 3 to 5 plants (about 10 g), from just below the two upper side leaves, were used. Since variety showed no consistent effect, averages of the five varieties at each time of analysis are indicated. Between points connected by solid lines the flats were in the laboratory, with diffuse sunlight during the daytime, while between points joined by broken lines they were in the open on the roof.

CHART 1.



It is evident from Chart 1 that there was a rapid loss of ascorbic acid when the plants were kept in the laboratory over night, and a rapid recovery when the plants were exposed to direct sunlight.

This observation raises the question of the role of ascorbic acid in plant life, about which little is known in comparison with our knowledge of its functions in animal physiology. The loss of Vitamin C in market vegetables is commonly ascribed to atmospheric oxidation. The much more rapid losses in these growing plants suggests its use in some physiological process, with solar rays as essential to its production.

We also have evidence of a positive correlation between ascorbic acid and sugar in the ripe tomato fruit. Is it possible that ascorbic acid is a step in the formation of other carbohydrates? We present these data in the hope that others may carry such studies further, since they are beyond our province.

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INEFFICACY OF PANTOTHENIC ACID AGAINST THE GRAYING OF FUR

GYÖRGY and Poling have recently reported[1] the results of studies which indicated that pantothenic acid has a curative effect on the nutritional achromotrichia

[6] Because of limitations of space, at the suggestion of the editor the detailed descriptions of these viruses are omitted. These are being submitted to *Phytopathology*.

[7] T. Petri, *Bol. R. Staz. Pat. Veg.*, n.s., 11: 105–114, 1931.

[8] Howard S. Fawcett, "Psorosis: In Citrus Diseases and Their Control." 2nd ed., pp. 188 to 203. New York: McGraw-Hill Book Company, 1936.

[9] *Idem, Phytopathology*, 24: 659–668, 3 figures, 1934.

[10] *Idem, Phytopathology*, 28: 669, 1938 (abst.) and 29: 6, 1939 (abst.).

[1] P. György and C. E. Poling, SCIENCE, 92: 202, 1940.

of rats maintained on a diet devoid of pantothenic acid. These results are in apparent conflict with observations made in the writer's laboratory. In our experiments, neither pantothenic acid concentrates nor pure pantothenic acid exhibited a preventive or curative effect on the gray hair of rats, although the rate of growth and the length of life were greatly enhanced. Evidently, some other circumstances which we can not as yet define influence the occurrence of achromotrichia. We note that our diet differs from that of György and Poling most conspicuously in the substitution of 8 per cent. butter for 2 per cent. corn oil. Such a difference might result in significantly differing amounts of the factor described by Nielsen, Oleson and Elvehjem.[2]

Our rats in which graying of hair occurred were maintained on the following basal diet: sucrose (or starch) 76 per cent., purified casein 18 per cent., salts 4 per cent., and corn oil 2 per cent., supplemented with 24 micrograms B_1, 40 micrograms B_2, 50 micrograms B_6, 6 mgs nicotinic acid and 6 mgs choline every other day and two drops of halibut liver oil weekly.

Group 1. Five litter mates, 2 black, 1 piebald, 1 tan and 1 white, received the basal sucrose diet. The two black rats as well as the tan one received, in addition to the above vitamins, every other day, 0.571 mg of Ba pantothenate of 40 per cent. purity derived from natural sources. Gray hair was observed in both black rats on the 16th day after the Ba pantothenate was first instituted and persisted until the experiment terminated four and one half months later. The tan rat on Ba pantothenate showed no changes in the fur. The white and piebald rats which received no Ba pantothenate developed a "rustiness" of the fur around the head on the 20th and 27th day, respectively.

Group 2. This group was composed of seven black littermates. Five of them were maintained on the above basal sucrose diet, while the remaining two received a basal diet in which methanol extracted starch was substituted for the sucrose. Three of the five rats on the sucrose diet received, in addition to the above vitamins, 4 mgs of methanol starch extract every other day. All five rats on the sucrose diet developed gray hair by the 28th day of the experiment. Two days later the starch extract was discontinued in the three rats receiving this supplement and two days later all seven rats were thereafter given 500 micrograms Ba pantothenate of 40 per cent. purity every other day. On the fifth day after the institution of Ba pantothenate, graying of the fur was observed in the two rats on the extracted starch diet. Two of the sucrose rats also showed "rustiness" of the fur about the head while on the Ba pantothenate. Twenty-five days after the institution of Ba pantothenate, 4 gms of wheat bran extract were given every other day to the three rats which had originally received the starch extract and to one of the rats on the extracted starch diet. The graying persisted in all rats during the subsequent six weeks. At this time pure Ca pantothenate became available and was substituted for impure Ba pantothenate in the amount of 200 micrograms Ca pantothenate every other day. Four of the rats on the sucrose diet and one on the extracted starch diet showed no improvement in gray hair during the subsequent two weeks, while the remaining two rats, one on sucrose and wheat bran extract and one on the extracted starch diet and wheat bran extract, showed a general decrease in graying.

Group 3. Thirteen black rats were maintained on the above sucrose diet supplemented with 6 mgs vitamin C, 200 micrograms vitamin K and 500 micrograms Ba pantothenate of 40 per cent. purity in addition to the previously mentioned vitamins every other day, and 21 mgs alpha tocopherol and 350 mgs linseed oil weekly. In addition, four of the rats received 2 gms waste cane molasses, three received 4 cc steep water, a by-product of starch manufacture, and three were given 400 mgs wheat germ every other day. Five weeks later, pure Ca pantothenate became available and was substituted for 40 per cent. pure Ba pantothenate in the amount of 200 micrograms every other day. By the 11th day after Ca pantothenate was first instituted, all the rats receiving wheat germ and steep water, one of the four receiving molasses and one of the three receiving none of these special supplements developed gray hair. On the 25th day, graying was observed in the remaining three rats on molasses and in one of the two remaining rats receiving none of the special supplements. The other rat of this latter group never developed gray hair.

The pantothenic acid salts used were kindly supplied in part by Merck and Company, Inc., Rahway, N. J., and in part by Professor R. J. Williams, of the University of Texas.

R. R. WILLIAMS

SUMMIT, N. J.

[2] E. Nielson, J. J. Oleson and C. A. Elvehjem, *Jour. Biol. Chem.*, 133: 637, 1940.

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